

# **APPENDIX D**

## **DWORSHAK SPECIAL OPERATIONS**



## INTRODUCTION

The only special operation involving the Dworshak project was cool water releases from July 3 through September 12. The NOAA Fisheries 2000 Biological Opinion calls for cold water releases from the Dworshak reservoir from July through August to augment the Snake River flows and reduce water temperatures. Without the release of this cold water temperatures on the Snake River could reach up to 75° F. In order to enhance fish survival in this reach of the Snake River, the Technical Management Team (TMT) makes recommendations on how to manage the cool water releases from Dworshak concerning the amount of water to be released from the Dworshak reservoir and the temperature of that released water. In order to facilitate the TMT's ability to formulate recommendations the Reservoir Control Center (RCC) Water Quality Team completed an analysis that would provide an estimate of how long water temperatures could be maintained at 45° F. This analysis was submitted to the TMT at the July 9, 2003 meeting. This report describes the calculations, the rationale used to develop them, actual operations and final results.

Based on the calculations described in this appendix, it was estimated that 45° F water releases from Dworshak could be maintain for up to 7.4 weeks. The calculations also indicated that the volume of water available to be released and the ability to access the cold water (the limitation of where the selector gates could be set at) was more limiting than the ability to maintain 45° F.

### Calculations for 2003 Dworshak Cool Water Releases

The determination of how long water could be released at a temperature of 45°F was performed using mass balance calculations and two pieces of information: Dworshak Reservoir temperature profiles and gross storage table figures.

The Dworshak temperature profiles were derived from resistance thermal devices (RTDs), embedded in the face of the dam at the time of construction. Water temperatures measured at varying depths of the reservoir provided a profile of the reservoirs' thermal stratification. As shown in Table D-1, July 10, 2003 and July 17, 2002 temperature profiles were used to provide the current temperature profile and the projected temperature profile respectively. Since water is physically pulled from the reservoir through intake gates of up to 40 ft. in length, average water temperatures over that 40 ft was calculated, (shown in Table D-1). Figure D-4 shows the changes in Dworshak temperature profiles from January through October 2003.

Gross storage tables, which are available through the Corps' Reservoir Control Center, show the volume of water stored at the various elevations at the different projects. As shown in Table D-1, gross storage information was cross-referenced with the temperature profiles to determine the volume of warm or cool water was available for temperature augmentation.

Temperature and water mass balance calculations were performed to see how long 45° F water releases could be maintained. A constant release of 13.8 KCFS per day was used in the calculations because this is Dworshak full powerhouse outflow capacity, plus 3.8 kcfs

spill as passed through the regulating outlets. The spill amount is limited by the TDG generated at the fixed monitoring station (FMS) downstream of Dworshak. An operational goal is not to exceed 110% TDG as measured at the FMS.

To perform the temperature mass balance, the temperature profiles and gross storage tables were used to calculate the percent each selector gate contributed toward the resultant release temperature and the number of weeks that 45° F could be maintained. Table D-2 shows the calculations. Based on the temperature calculations, 45° F water releases could be maintained for 12.3 weeks at a flow rate of 13.8 kcfs. The right mix of water temperature would be available longer than the volume of water. Although the calculations indicate that 12 weeks is possible, achieving it may be difficult because of the physical restriction of setting the selector gates at elevations needed to get the correct mix of cold and warm water to achieve 45° F water.

Maintaining 45° F water releases for 12.3 weeks is longer than what the water mass balance would allow, which only considers the amount of water available, ignoring temperature requirements. Dworshak 60 year average inflows and outflows were used to perform mass balance and calculate the length of time that 45° F could be maintained. As Table D-3 shows, 13.8 kcfs per day releases could be continued for 7.4 weeks before there was no more water to release.

Using both sets of calculations together, it can be concluded that the limiting factor in temperature augmentation of the Snake River would be the flow restrictions and not the length of time that 45° F water releases could be maintained.

**TABLE D-1**

<b>TEMPERATURE PROFILES AND GROSS STORAGE AMOUNTS</b>						
	AVAILABLE H <sub>2</sub> O	GROSS STORAGE	AVERAGE TEMP	WATER	AVERAGE TEMP	WATER
ELEVATION	KSFD	KSFD	W/WATER USED	TEMP(7/17/02)	W/WATER USED	TEMP(7/10/03)
1574	131.7	1518.4		<b>58.6</b>		65.5
1557	58.4	1386.7				
<b>1549</b>	<b>173.2</b>	<b>1328.3</b>		48.9		52.7
1524	90.5	1155.1		45.6		49
1510	64.9	1064.6				
1499	22.2	999.7	51.0	45.2	55.7	47.4
1495	108.4	977.5				
1474	78.6	869.1		44.5		45.4
1457.6	39.9	790.5				
1449	40.6	750.6		43.3		43.8
1440	65	710				
1424	111	645	41.5	40.0	42.5	42.2
1399	34	534.0		41.3		41.5
1387	34	500.0				
1374	66	466		40.6		41.2
1349	67	400	39.9	<b>39.8</b>	41.0	40.9
1324		333		39.3		40.9

**TABLE D-2**

<b>PERCENTAGE CONTRIBUTION TOWARD TEMPERATURE BALANCE</b>								
<b>OUTLETS</b>	<b>Possible Elevation</b>	<b>Actual Elevation- ft</b>	<b>Total Flow Amt KCFS or KSFD</b>	<b>% of Total Flow</b>	<b>Outflow Temp (7/17/02)</b>	<b>Wt. Contributions to total Temp.</b>	<b>Outflow Temp (7/10/03)</b>	<b>Wt. Contributions to total Temp.</b>
RO 1,2,3	1350	1350	3.9	0.28	39.9	11.3	41.0	11.6
Selector Gate 1&2	1510 - 1435	1424	4.9	0.36	41.5	14.7	42.5	15.1
Selector Gate 3	1510 - 1435	1574-1499	5	0.36	51.0	18.5	55.7	20.2
Daily Averages			13.8	1.0		44.5		46.9
*Note: we generally try to maintain plant operations within 1% of max. efficiency, which requires that we have near max. flows through an open gate.								
* Note: 1 KCFS for 1 day = 1KSFD								

**TABLE D-3**

<b>MASS BALANCE OF RESERVOIR FOR TEMPERATURE AND WATER</b>				
<b>WATERS USED IN TEMP CONTROL EFFORT</b>	<b>H2O Used in 1 week</b>	<b>Total H2O Available for effort (KSFD)</b>	<b>Elevations water is taken from</b>	<b># weeks we can maintain 45 degrees T</b>
Warm water taken from 1510 ft	35	540.9	1574-1499	15.5
Middle Temperature water taken from 1458-1380.6 ft	34.3	477.5	1380.6-1457 ft	13.9
Cold water taken from 1380.6-1350 ft	27.3	167.0	1380.6-1350 ft	6.1
<b>Number of weeks based on temperature profiles</b>	<b>96.6</b>	<b>1185.4</b>	<b>1565 - 1350</b>	<b>12.3</b>
60 yr average of outflows from 7/1 to 10/1		911.6		
60 yr average of inflows from 7/1 to 10/1		198.6		
60 yr average of outflows - inflows	96.6	713.0		
<b>Number of weeks based on water balance</b>	<b>96.6</b>	<b>713.0</b>		<b>7.4</b>

#### Actual Operations And Final Results:

The actual operations at Dworshak are summarized in Tables 4 and 5, which provide an overall perspective of outflow and temperature ranges and averages. Table D-4 shows the outflow ranges, (as calculated from the maximum and minimum) and averages for the two week time periods between June 18 and September 12, 2003. The outflows varied between 1.6 and 14.2 kcfs. As Table D-5 shows the temperature ranges and averages for the two-week time periods between June 18 and September 12. The temperature averages varied between 45.0 and 51.6 °F.

The effects of Dworshak outflow and cool water releases on the Snake River can be seen in Figures 1, 2 and 3. Figure D-1 shows the Lower Granite tailwater temperature, the dates when temperature changes were made at Dworshak and what the changes were. Dworshak releases were maintained at 48 °F from July 2 – 11; and 45 °F from July 12 to September 12. As Figure D-1 shows, the cool water releases from Dworshak kept Lower Granite tailwater temperatures at or below the State water quality standard of 68 °F most of the time while the Anatone tailwater temperature continued to rise to a high of 75 °F on July 28 – 30, 2003.

Figure D-2 compares the Dworshak discharge against the Lower Granite inflow during July 3 through September 11, 2003 and shows that the Dworshak discharge comprises approximately 35% of the Lower Granite inflow. On some days (August 3 and 4, 2003),

Dworshak outflow comprises as much as 46% of the Lower Granite inflow, which emphasizes how important Dworshak outflow can be to Snake River flow augmentation during July through September.

Figure D-3 shows the combined effects of using Dworshak water for flow augmentation and temperature control of the Snake River. As Figure D-3 shows, the Dworshak outflow temperature and flow produced a combined effect of lowering the Lower Granite tailwater temperature approximately 5.7 degrees during July 3 through September 11, 2003.

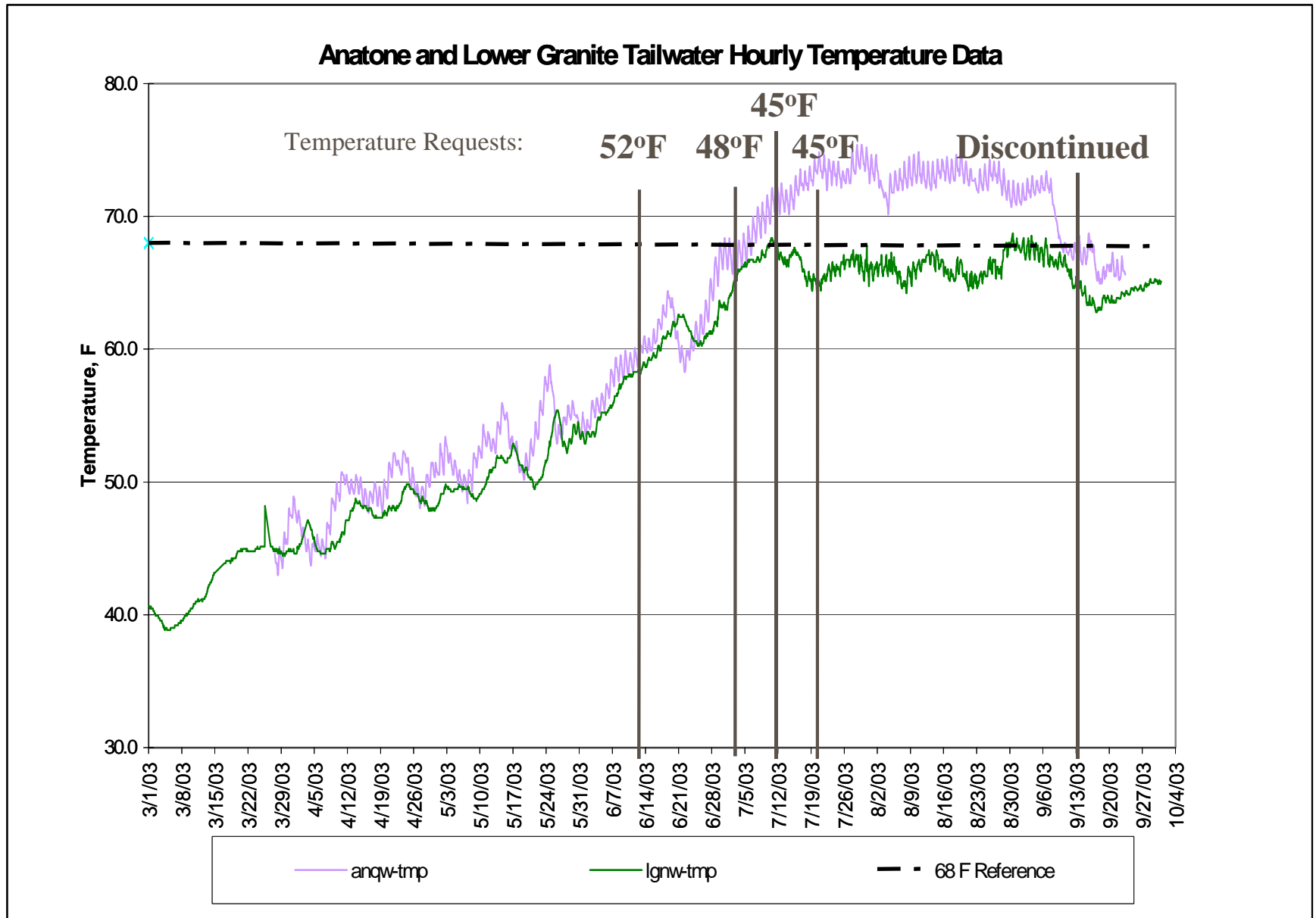
**TABLE D-4**

<b>OUTFLOW RANGE</b>		
<b>Dates</b>	<b>Outflows Range (KCFS)</b>	<b>Ave. Outflows (KCFS)</b>
June 18 - July 1	1.6 - 7.5	3.8
July 2 - July 16	2.1 - 14.2	11.3
July 17 - July 30	4.5 - 14.2	12.8
July 31 - Aug 13	8.0 - 12.0	10.1
Aug 14 - Aug 27	5.7 - 10.4	8.3
Aug 28 - Sept 12	2.4 - 9.5	7.1

**TABLE D-5**

<b>TEMPERATURE RANGE</b>		
<b>Dates</b>	<b>Temperature Range (F)</b>	<b>Ave. Temp. (F)</b>
June 18 - July 1	49.8 - 53.1	51.6
July 2 - July 16	44.2 - 53.1	47.1
July 17 - July 30	44.6 - 49.5	45.6
July 31 - Aug 13	43.9 - 45.7	45.0
Aug 14 - Aug 27	43.5 - 47.3	45.2
Aug 28 - Sept 12	43.7 - 48.0	45.4

FIGURE D-1



**FIGURE D-2**

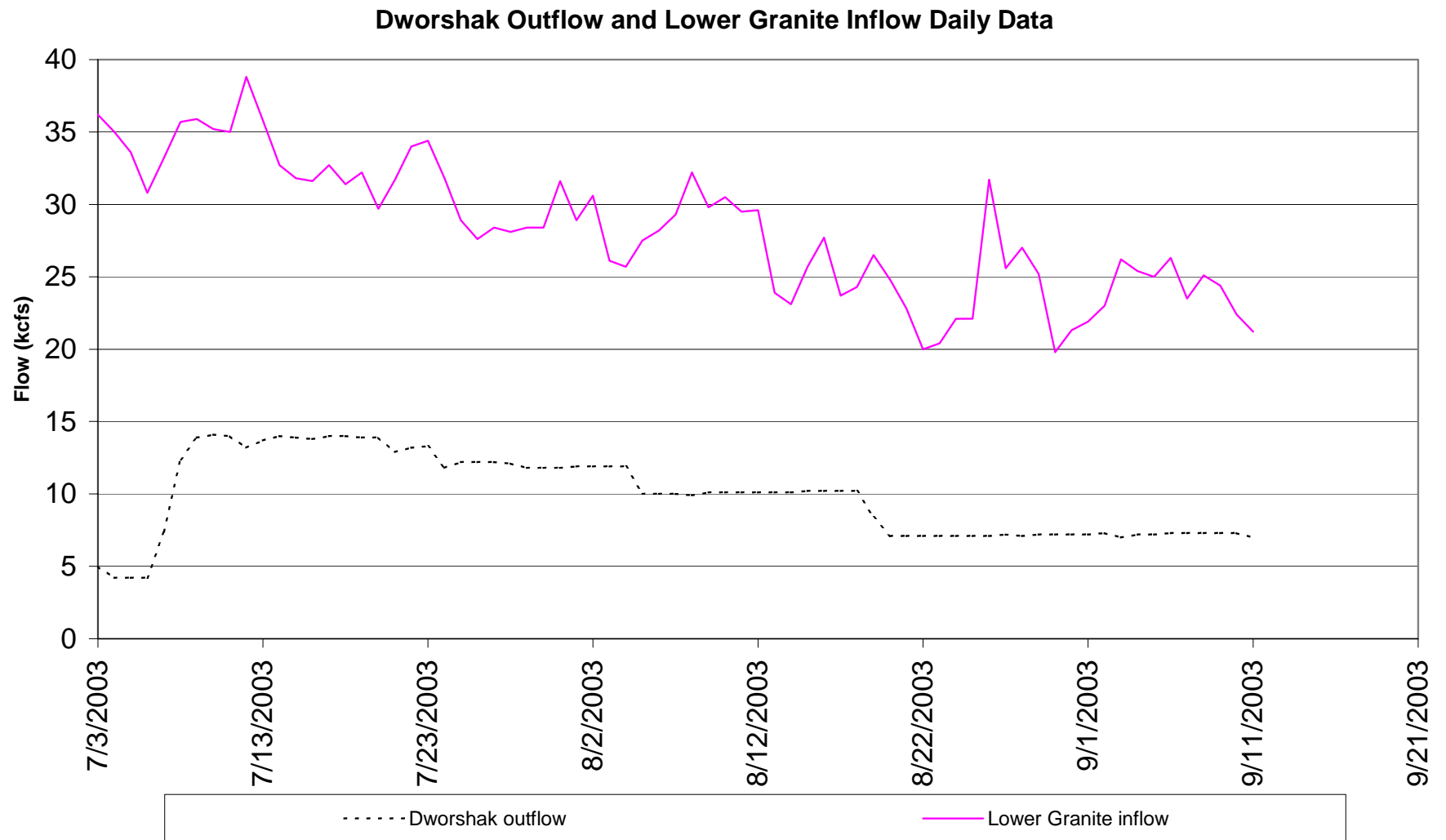
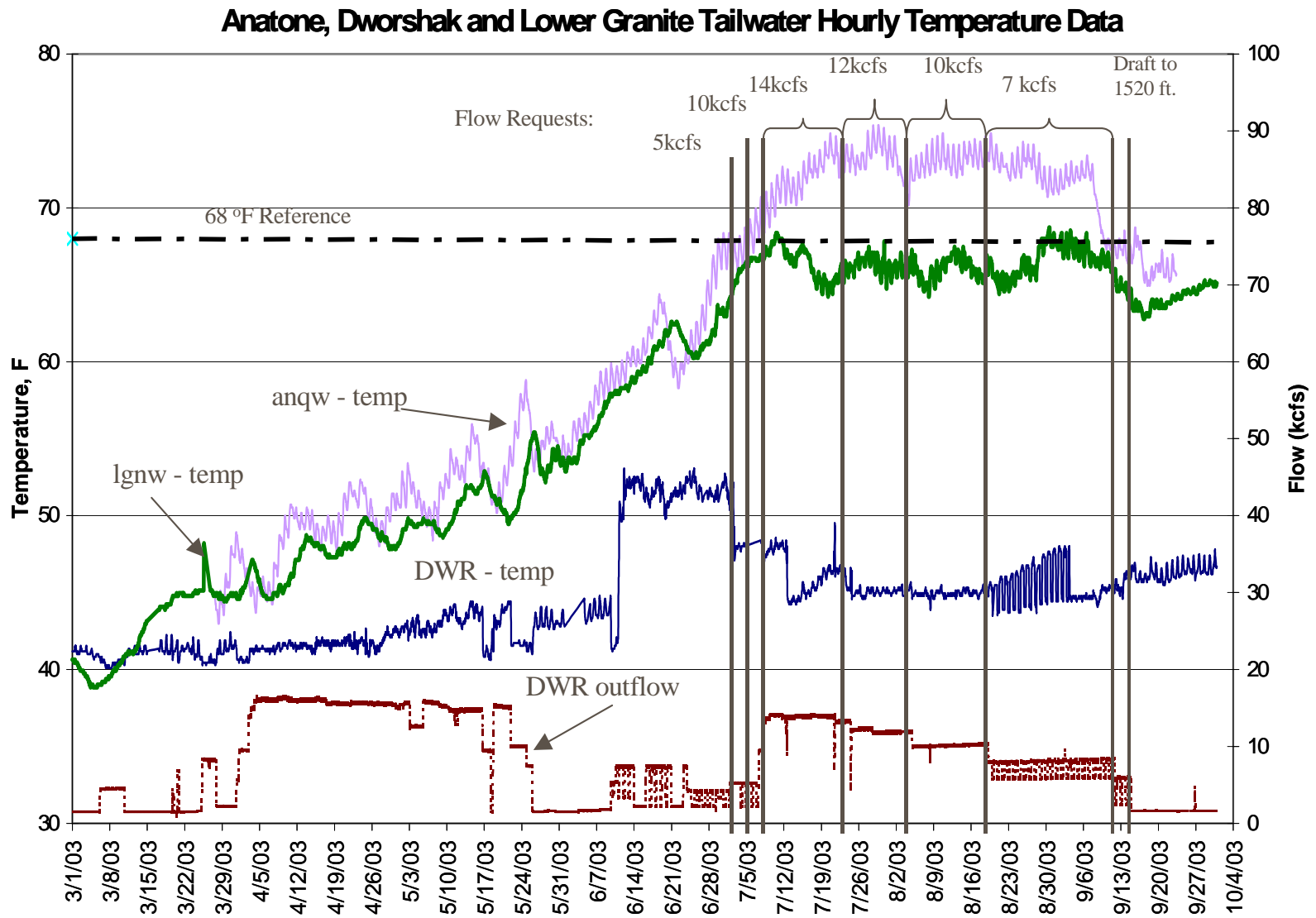




FIGURE D-3



**FIGURE D-4**  
**DWORSHAK TEMPERATURE PROFILES**  
 January – October

